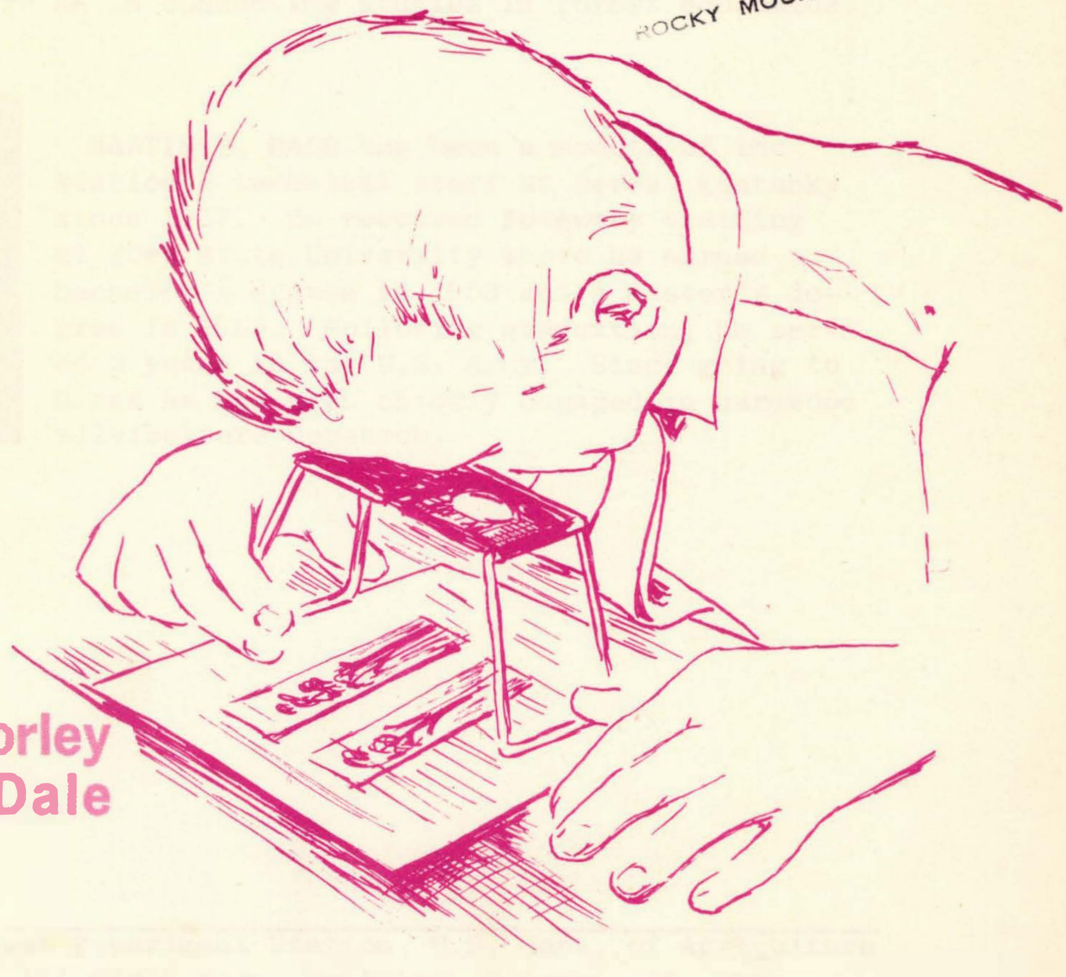
Mr. Crow

Recording TREE DEFECTS in STEREO



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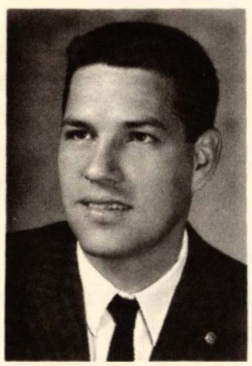
DAVID P. WORLEY graduated from the New York State College of Forestry in 1943 and received his master of forestry degree from Duke University in 1947. He then taught forest management at Pennsylvania State University for 10 years before coming to the Central States Station in 1957. During this time he also did some consulting work in forest engineering and the use of aerial photographs in forestry. Worley has authored more than 20 publications, chiefly in the fields of aerial photo interpretation and woody plant control. He is currently assigned to the Berea Forest Research Center in Kentucky where he is conducting studies in forest economics.



MARTIN E. DALE has been a member of the Station's technical staff at Berea, Kentucky since 1957. He received forestry training at Iowa State University where he earned a bachelor's degree in 1953 and a master's degree in 1955. Following graduation, he served 2 years in the U.S. Army. Since going to Berea he has been chiefly engaged in hardwood silviculture research.

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Recording TREE DEFECTS in STEREO

By

David P. Worley and Martin E. Dale

The fast growing realization that timber quality is every bit as important as quantity has sparked a lot of research into methods of determining log and tree quality. Quality determinations are particularly important in the management of hardwoods, because the value of a high-quality hardwood tree is many times that of its run-of-the-mill neighbor.

Since most forest management yield studies are long-term projects, it behooves the researcher to develop accurate and practical methods for recording the surface defects that influence quality so that the effects of the silvicultural systems or methods being tested can be evaluated in terms of quality as well as volume production. Would not the research conclusions be stronger if a record of the defects existing at the outset of a management experiment were available for comparison with periodic or final results? Ideally such a record should be easily made, objective, and consistent for different trees and reappraisals of the same tree.

Currently the most common solution to this problem is tree diagramming. This paper describes another method for recording the surface orientation of defects: The use of stereo pairs of photographs.

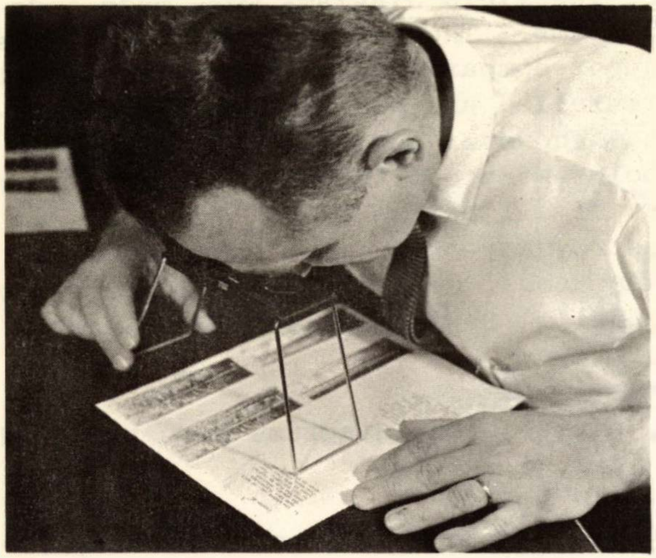
THE PHOTO TECHNIQUE

Stereo pairs of photographs are made of each of the four faces of a tree using a tripod-mounted camera. A slotted camera mount makes it possible to change the camera station quickly and accurately for each of the two photos (fig. 1). Camera stations are 12 inches apart. Each picture of the stereo pair can be made on a separate film or both pictures can be made on the same film by cutting an exposure slide lengthwise and exposing first one side of the film, then the other (fig. 2, p. 6). It is important that the special slide be used only for making exposures, that it is replaced before removing the film holder from the camera between exposures, and that the tree be properly oriented and focused on the ground glass for each exposure. A fast film of moderate to low contrast and the smallest lens opening possible are recommended in order to get the most detail. Exposure should be 1/50 to 1/100 second in order to eliminate fuzziness caused by movement of the camera or the tree. For best exposure use an average light reading of both the shaded and bright portions of the tree face.

Analytical methods developed by photo interpreters for other uses can play an important role for evaluating the defects in these pictures. However, no attempt was made to develop such techniques or instruments at this time. In the tests made, the stereo pair was used for transcribing defects to a tree diagram. Only a 2x power pocket stereoscope and the best judgment of the interpreter, unaided by interpretation aids, were used.

Figure 1.--The camera mount used for making stereo pairs of photographs in the field.

FOR THE READER WHO HAS NEVER USED STEREOSCOPIC PHOTOGRAPHS



- Place the paired photos on a flat surface (table top) in the same position as they were taken (left photo on the left side, right photo on the right). The two images of the same object should be about 2 1/2 inches apart.
- Place a folding stereoscope directly over the photos, one lens over each photo.
- As you look through the lenses, shift the position of the stereoscope slightly by rotating it one way or the other until you see only one image in three dimensions.

NOTE: The stereo images on pages 6 and 7 are not as clear as they would be on the photographs themselves because we had to screen the photos in order to print them.

A TEST OF THE PROCEDURE

The four faces of the lower two logs of six white oak trees were photographed. A 4 x 5 Crown Graphic camera using Tri X Panchromatic film was stationed about 50 feet from the tree, and it produced the pictures at a scale of about 1/95. The shaded faces were equal in quality of detail to those taken in full sunlight (fig. 3, p. 7).

Diagrams of all 24 faces were made to show the location of the surface defects as identified from the stereo pairs. Because both logs appeared on the same stereo pair both were put on one diagram.

After the diagrams were made from the photos the trees were diagrammed in the field using 6x power binoculars and a sectional measuring pole. The field diagrams were made independently of the photo diagrams. The same diagram format was used to facilitate subsequent comparisons between the two methods. Later the trees were felled and all 24 faces were measured and diagrammed again. Wherever possible the trees were felled so that the tree boles were off the ground. This gave a clear, unobstructed view of all parts of the tree bole and more important did not destroy any of the surface characteristics except possibly very small dead sprouts which may have snapped off when the tree fell. So the felled-tree diagram is considered highly accurate.

To summarize then, three defect diagrams were produced for each of the 24 faces (fig. 4, p. 5):

1. Diagrams of standing trees based on the interpretation of stereo pairs of photographs.

2. Diagrams of standing trees drawn in the field using binoculars and measuring pole.

3. Diagrams of felled trees measured with a tape.

Special symbols were adopted so that the origin as well as the location of the defects could be recorded (See p. 11). This is particularly important in management studies because for example, the presence of bud clusters and adventitious branches may retard development of overgrowth.

The basic defect pattern for all three diagrams was similar. Differences in location and identification though do appear, and it is necessary to identify these differences. Three different types of errors were made: (1) missing a defect; (2) improperly identifying a defect; and (3) calling a defect where none existed.

Accuracy of the field and photo methods was compared by selecting isolated defects from the felled-tree diagrams and then checking these on each of the other diagrams to determine the percentage of defects correctly located and identified (table 1, p. 9). Defects were considered isolated if separated by at least 1 foot of clear stem above and below the defect.

Figure 4.--
DIAGRAM A was made by identifying the defects on a felled tree and measuring their location with a tape.
DIAGRAM B was made by identifying the defects in the standing tree with 6x binoculars and estimating their location with a sectional measuring pole.
DIAGRAM C was made by analyzing the defects from the stereo pair shown in figure 3A.

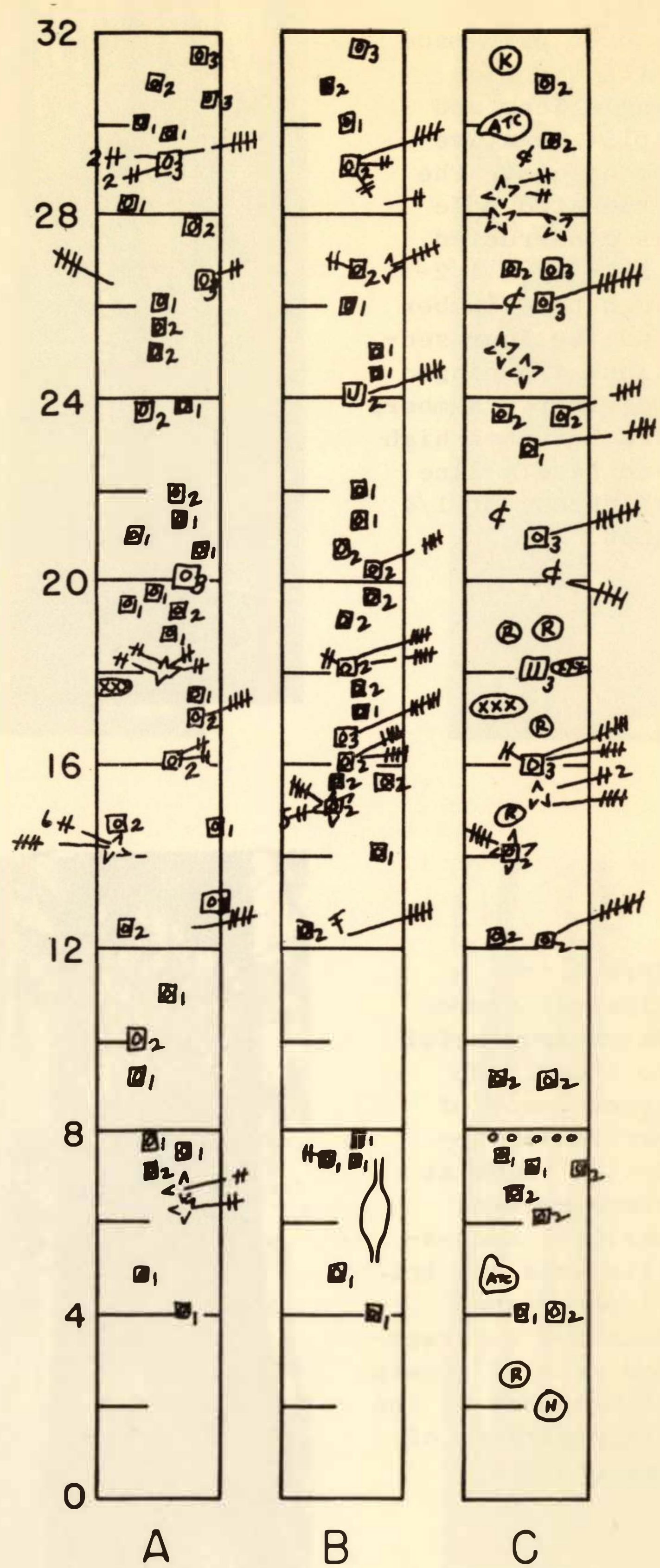
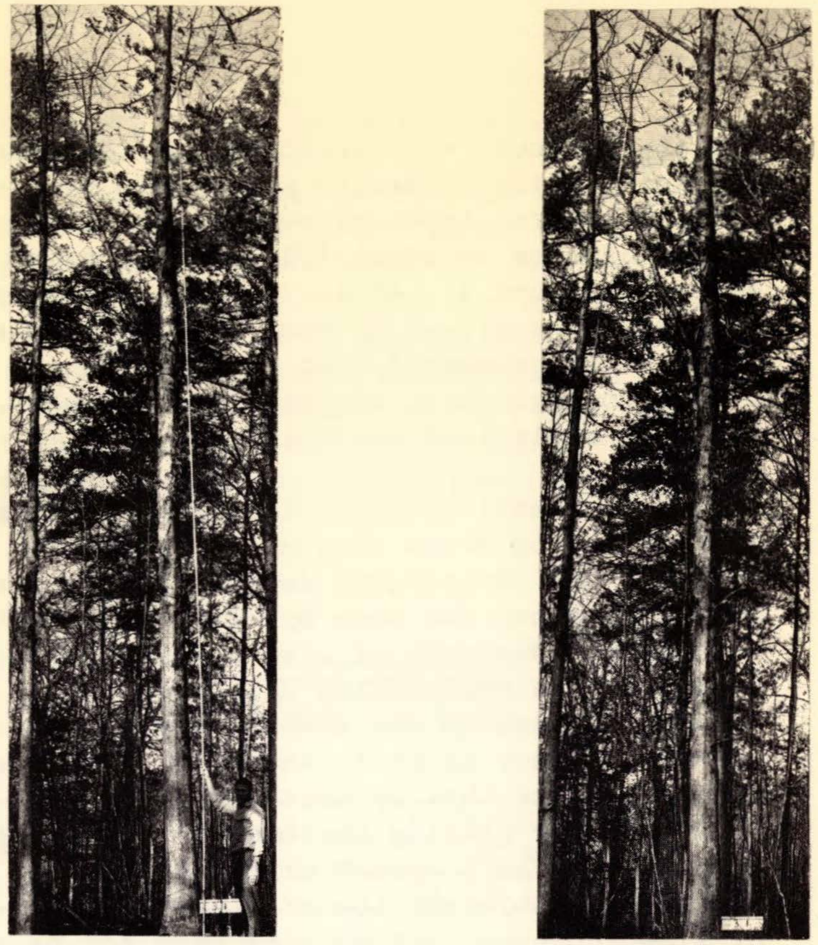


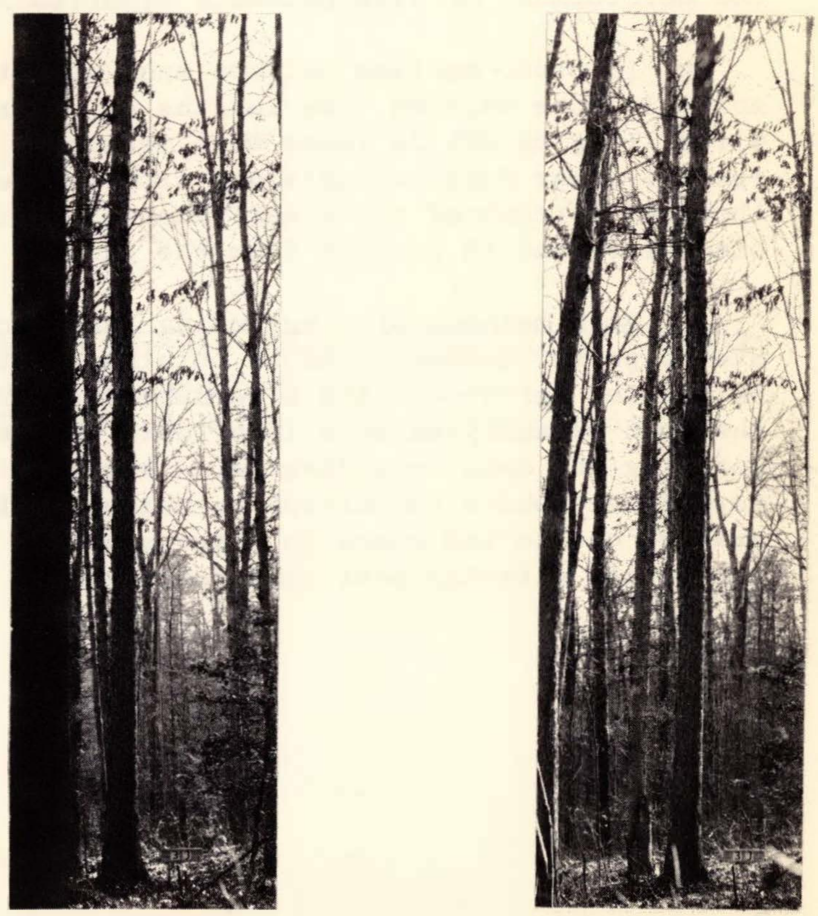
Figure 2.--Stereo pair made with the wide angle lens and split negative technique. The graduated pole is constructed of 1- by 2 1/2-inch pine lumber and the four sections are hinged together. Numbers are 2 inches high and have a line thickness of 1/4 inch.

Figure 5.--Close-up stereo pairs are useful to trace the development of particular defects. Made at remeasurement periods, successive sets can be compared and measured to trace the rate of growth of branches or the disappearance of overgrowths.

Figure 3.--



A. The stereo pair of this tree face illustrates the quality obtained when the face is lighted by full sunlight. Diagrams of this face made from these prints are shown in figure 4.



B. These pictures were made of the face opposite the one shown above. The face was in full shade. Often it is necessary to shade the lens in such situations to prevent undue glare. The photo quality though is equal to the sunny face above.

Isolated defects were selected for this analysis to alleviate confusion which otherwise would have developed due to a tendency of several types of defects to cluster about one another. This confusion in identifying and locating defects is clearly shown in figure 4. At 11 feet an overgrowth less than 1/2 inch wide was missed by both methods. No analytical difficulties are presented. At 14 feet, on the other hand, a complex of overgrowths, adventitious branches, and bud clusters leads to analytical confusion.

For small defects, less than half an inch in diameter, neither method seems adequate. In general the accuracy in locating and identifying defects larger than 1/2 inch in diameter is about the same by either the photo or binocular field technique. Judgment of size was poorer by the photo method because no interpretation aids were used. However, mensurational techniques can undoubtedly be developed to correct this deficiency in photo analysis. At this point it is well to reemphasize that by neither method were all defects identified. So for grading purposes both methods might be considered inadequate. As a record of the changes of visible defects on the merchantable portion of standing trees over a long period of time, however, all defects need not be recognized. The important thing is that an objective prior record be available to compare with later records or the final graded logs to show the development or disappearance of defects identified earlier.

In order to find out how many defects were called where actually none existed, the lengths of clear sections more than 2 feet long on all 24 faces were measured. A total of 222 feet of clear face was obtained from the felled-tree diagrams. About 87 percent of the clear face was so identified using binoculars and 65 percent from the photos.

Both methods of diagramming take about the same time. Stereo pairs, however, can be obtained in the field in 15 to 30 minutes per tree. And a permanent record is thus obtained that can be analyzed at a later date in the office by transcribing the data to a diagram as was done in the tests or by more direct photo comparison techniques. It requires on the average one to two hours to diagram a tree in the field using binoculars with the most time required for the smaller trees.

The technique of using stereo pairs for recording surface defects on standing trees in this test was not quite as accurate as the field method though neither method was error free. The errors of omission were about the same, though the errors of commission were higher for the photo method. For the purpose of obtaining a record of surface defects the photo technique offers a method which takes 1/8 to 1/4 as long as conventional field techniques. In addition, photographs offer an important advantage over field diagrams in that they are subject to independent and repeated interpretations at future dates. Once a tree diagram is made by conventional means, any personal bias cannot be rectified.

Table 1.--Comparison of accuracy in locating and identifying surface defects on standing trees

Defect: Type	Defect: Diameter (inches)	Total defects	Defects correctly located and identified: Field	Defects correctly located and identified: Photo
		Number	Percent	Percent
Overgrowths[1]	-1/2 (butt log)	17	50	20
	-1/2 (second log)	8	25	25
	1/2-2	15	80	85
	2+	22	100	85
Branches	-1/2	68	77	44
	1/2-2	22	95	70
	2+	11	100	100
Miscellaneous[2]		30	70	70

1/ Overgrowths are the surface abnormalities caused by knots or bark pockets, insect attacks, and bark distortions.

2/ Includes defects such as bulge, canker, conk, holes, seams, and wounds.

Technique Variations with Other Equipment

The interest stimulated by these trials led to isolated comparisons using photographic materials and procedures suggested by other foresters. Prominent among these were the use of a wide-angle lens on the Crown Graphic camera, and the use of a Stereo Realist camera with color film.

The wide-angle lens looks particularly promising. It produced pictures as easily interpreted by stereo viewing as those taken with the conventional lens, and had the decided advantage of cutting the distance from the tree to the camera station in half. This helps meet the problem of eliminating brush and branches between the camera and tree which may obscure the bole of the tree (fig. 2). Use of color film was a failure because detail was completely lost on the shaded faces of the trees.

Use in Detail Records of Particular Defects

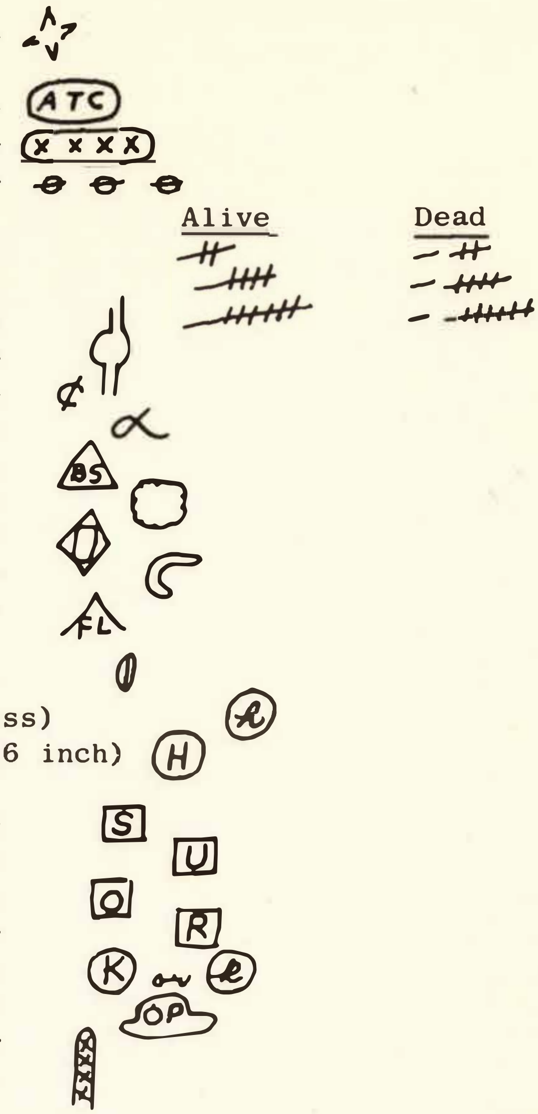
In the course of working with stereo prints it was discovered that a detailed record of defect development could be kept of specific defects (fig. 5, p. 6). The development of the sprouts, bud clusters, and old overgrowths can be traced from one remeasurement to the next. If desired, actual changes in size could be recorded by placing a scale under the defect.

CONCLUSIONS

Stereo pairs of photographs can be a useful tool in forest management research for following defect changes due to the management techniques being studied. They can be used to: (1) Record the surface defects on standing trees, and (2) record the changes taking place on surface defects. They can be used to trace defect development throughout the life of the tree for comparison with the quality of the product that is finally recovered when the tree is felled. Conclusions as to the value of a particular management technique will be thus strengthened.

DEFECT SYMBOLS FOR BARK SURFACES

Adventitious buds ------------
Bark distortions
  Abrupt textural change -----
  Horizontal breaks ----------
Bird peck --------------------
Branches and suckers
  Under 1/2 inch -------------
  Between 1/2 - 2 inches -----
  Over 2 inches --------------
Bulge ------------------------
Bump -------------------------
Burl -------------------------
Butt scar --------------------
Butt swell -------------------
Canker -----------------------
Conk -------------------------
Flange or flute --------------
Holes
  Grub and ant holes ---------
  Small holes (3/16 inch or less)
  Medium-large holes (over 3/16 inch)
1/ Knots
  Sound ----------------------
  Unsound --------------------
  Overgrown ------------------
  Rotten ---------------------
  Knot holes -----------------
Operational ------------------
Seam -------------------------



1/ Indicate size with subscript as:

Less than 1/2 inch ---------	1
Between 1/2 - 2 inches -----	2
Over 2 inches --------------	3

The Central States Forest Experiment Station is headquartered at Columbus, Ohio and maintains major field offices at:

Ames, Iowa (in cooperation with Iowa State University)
Athens, Ohio (in cooperation with Ohio University)
Bedford, Indiana
Berea, Kentucky (in cooperation with Berea College)
Carbondale, Illinois (in cooperation with Southern Illinois University)
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